Low-Z impurity transport studies using CXRS at ASDEX Upgrade

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Impurities in fusion plasmas arise from many different sources including the erosion and sputtering of material from plasma facing components, the intentional injection of impurities for divertor cooling and core radiation control, and the production of helium from the fusion process itself. To achieve optimum fusion performance, future fusion reactors need to control the build up of both high- and low-Z impurities, especially helium, in the plasma core. Therefore, it is important to develop and validate our theoretical understanding of impurity transport in fusion plasmas. Recent experimental work on this topic at ASDEX Upgrade (AUG) has focused primarily on steady-state profiles, which deliver the ratio of the diffusive and convective transport coefficients [1]. However, from time dependent density profiles, which can be measured after applying an external perturbation (e.g. a fast impurity puff), the convective and diffusive components of the transport can be separately determined by solving an inverse problem, enabling a more in depth comparison to theory.

At the ASDEX Upgrade (AUG) experiment, a novel technique for modulating the boron content of the plasma has been developed. By modulating the power from the ion cyclotron resonance frequency (ICRF) antennas, a sinusoidal modulation of the boron density can be achieved. This signal can then be measured with the charge exchange recombination spectroscopy (CXRS) diagnostics, which can provide complete measurements of the boron density profiles with high spatial and temporal resolution. Since boron is a non-recycling impurity, the modelling of these profiles straightforwardly allows for a deduction of the transport coefficients. Using this method, the experimental boron transport coefficients can be determined over a wide range of plasma parameters. In this contribution, we will present a database of measured transport coefficient profiles, their dependencies on local plasma parameters, and a first comparison to neoclassical and gyrokinetic predictions.

References